

High Temporal Resolution Products  
from the Goddard EOS Data Assimilation System (GEOS DAS)  
(formerly DAO Swath Products)

Beginning in June 1998, the DAO will produce a new set of high temporal resolution products tailored specifically to the needs of the AM I instruments. Originally, the DAO planned to put these data out in special "satellite swaths" to match the field of view of the AM I instruments. However, after further study (see appendix A) the DAO has decided to not subset these products geographically but merely put them out on the full global grid.

Table 1 lists the high temporal resolution products to be provided by the DAO. These are based on requirements gathered from the AM I instrument teams as shown in Table 2. These data will have the following characteristics:

**Grid:** lat-lon. (Each grid point has an (I,J) index. "I" represents the longitude, 1 being the dateline and incrementing eastward. "J" represents the latitude, 1 being the south pole and incrementing northward. The grid does not wrap at the dateline. For example, on a 2 X 2.5 grid the I=144 longitude is 177.5E.)

**Horizontal Resolution:** 2 X 2.5 degree lat-lon. (This will increase to 1 X 1 degree lat-lon approximately 6 months after launch.)

**Vertical Resolution:** 24 mandatory pressure levels (1000 mb to .4 mb) or 70 sigma levels (surface to .01 mb) (see appendix B). Some fields are not meaningful above a certain level. For example, the GEOS DAS does not contain accurate cloud or humidity information above 100 mb. Thus, these fields will be reported at only the lowest 12 pressure levels (1000 mb to 70 mb) and/or the lowest 35 sigma levels (surface to approximately 40 mb).

**Format:** EOS-HDF

**Source:** Goddard DAAC

for further information contact:

Yong Li: 301-262-0191  
lyong@dao.gsfc.nasa.gov

or

Jim Stobie: 301-805-8441  
stobie@dao.gsfc.nasa.gov

or see the DAO homepage at:

<http://dao.gsfc.nasa.gov/>

**Table 1**  
**High Temporal Resolution Products**

units	Data Type	Time Resloution	1 X 1 deg 1-Day File Size (MB)	2X2.5 deg 1-Day File Size (MB)
	<b>Precip and Moisture</b>			
none (0-1)	Soil Moisture (shallow)	3 hr	2	1
none (0-1)	Soil Moisture (root)	3 hr	2	1
none (0-1)	Soil Moisture (deep)	3 hr	2	1
g/kg	Canopy Air Specific Humidity	10 min	36	7
g/kg	Near-Surface Specific Humidity (2 meters)	10 min	36	7
g/kg	Near Surface Specific Humidity (10 meters)	10 min	36	7
g/kg	Specific Humidity Profile (12 lowest pressure levels)	1 hr	72	15
g/kg	Specific Humidity Profile (35 lowest sigma levels)	3 hr	70	14
gm/cm**2	Precipitable Water	1 hr	6	1
mm/dav	Total Precipitation	3 hr	1	1
Iron/day	Convective Precipitation	3 hr	1	1
mm	Snow Depth	3 hr	1	1
	<b>Clouds &amp; Radiation</b>			
mb	Cloud Top Pressure	1 hr	6	1
deg K	Cloud Top Temperature	1 hr	6	1
1/m	Cloud Optical Depth (12 lowest pressure levels)	1 hr	72	15
1/m	Cloud Optical Depth (35 lowest sigma levels)	3 hr	70	14
Urn	Low cloud optical Depth	1 hr	6	1
1/m	Mid Cloud Optical Depth	1 hr		1
1/m	High Cloud Optical Depth	1 hr	6	1
w/m**2	Outgoing SW Radiation	1 hr	6	1
w/m**2	Outgoing SW Radiation, Clear Sky	1 hr	6	1
none (0-1)	Albedo - NIR, Diffuse	1 hr	6	1
none (0-1)	Albedo - NIR, Direct	1 hr	6	1
none (0-1)	Albedo - Vis, Diffuse	1 hr	6	1
none (0-1)	Albedo - Vis, Direct	1 hr	6	1
mg/kg	Cloud Liquid Water (12 lowest pressure levels)	1 hr	72	15
mg/kg	Cloud Liquid Water (35 lowest sigma levels)	3 hr	70	14
	<b>Land &amp; Ocean Surface Temps</b>			
deg K	Skin Temperature	10 min	36	7
	<b>Boundary Conditions</b>			
none	Land, Water, Ice Flags	3 hr	1	1

units	Data Type	Time Resolution	1 X 1 deg 1-Day File Size (MB)	2 X 2.5 deg 1-Day File Size (MB)
	<b>Air Temperature</b>			
deg K	Temperature (2 meters)	10 min	36	7
deg K	Temperature (10 meters)	10 min	36	7
deg K	Temperature Profile (24 pressure levels)	1 hr	144	29
deg K	Temperature Profile (70 sigma levels)	3 hr	140	28
deg K	Tropopause Temperature	1 hr	6	1
	<b>Pressure &amp; Heights</b>			
(m/sec)**2	Surface Geopotential Height	1 hr	6	1
mb	Surface Pressure	1 hr	6	1
mb	Sea Level Pressure	1 hr	6	1
m	Upper Air Geopotential Heights (24 pressure levels)	3 hr	48	10
mb	Tropopause Pressure	1 hr	6	1
	<b>Winds</b>			
m/sec	Winds at 2 meters (u component)	1 hr	6	1
m/sec	Winds at 2 meters (v component)	1 hr	6	1
m/sec	Winds at 10 meters (u component)	1 hr	6	1
m/sec	Winds at 10 meters (v component)	1 hr	6	1
	<b>Chemical Constituents</b>			
ppmv	Ozone Profile (24 pressure levels)	3 hr	48	10

Most of the products in the above table have only one vertical level. The exceptions are the profile data. Profile data may be on either mandatory pressure levels or model sigma levels (see Appendix B ).

**Table 2**  
**EOS Instrument Requirements**

Launch Year		Platforms & Instruments																														
Platform		96								97				98				99		00				02								
		ADEOS								TRMM				AM1				BM1	ALT	PM1				CHEM1								
Parameter	GEOS-1	AVHRR	ILAS	TPG	ASCAT	QZTS	POLDER	HIS	TOPS	CERS	LUS	PR	TM	SVRS	ASTER	CERS	MSR	MODIS	MODIS	SAGE III	GLAS	AIRS	ACSIL	CERS	HIS	TMIR	MODIS	PAROL/S	HIS	ILIS	POIFS	
Surface Pressure	●				●	●				●						●	●	●	●			●					●					
Surface Winds	●				●	●							●		●		●	●					●				●					
Geopotential Heights	●									●					●	●									●				●			
Temperature Profile	●					●				●			●		●	●	●	●	●	●		●			●		●			●		
Surface Air Temperature	●				●	●							●		●		●	●	●			●					●					
Ground Temperature	●									●					●	●									●							
Moisture Profile	●					●				●			●		●	●	●	●	●			●			●		●					
Precipitable Water	●									●						●	●								●							
Precipitation	●																	●									●					
Surface Humidity	●				●															●		●										
Soil Moisture	●									●			●			●																
Outgoing SW Radiation	●																		●								●					
Outgoing SW Rad (clear)	●																		●								●					
Cloud Top Pressure	●																		●	●							●					
Cloud Properties	●																		●	●							●					
Surface Albedo	X									●						●				●												
Sea Surface Temperature	X					X				X						X	X					X	X		X	X		X				
Tropopause	○									●						●																
Snow/Ice Cover	○														●		●	●	●				●	●								
Ozone Profile	○					○				●					●	●	●	●	●			●			●			●				
Cloud Liquid Water	○												●			●												●				
Aerosols	○					○									○		○	○										●				
Visibility/ Optical Depth	○									○						○		○								●		●				
CO2	○																	○														
Cloud Emissivity	○																	○									○					
Surface Emissivity	○									○																						
KEY		● High quality DAO product available																○ No DAO product available														
		● Medium quality, DAO product available																X Available, but from other source														

This table lists the products required by the EOS instruments. If there is an entry of any kind, that instrument needs that product. The first column, **GEOS-1**, is not an instrument but represents the first DAO reanalysis project. This project was a prototype for future DAO reanalyses and has been evaluated extensively by the climate community. The quality values shown for GEOS-1 are based on these scientific evaluations. The quality values shown for subsequent version of the GEOSDAS, the AM1 version for example, are target values based on expected system improvements.

## Appendix A

Why Produce Global Gridded Products  
Instead of Swath Subsetted Products?

**Background.** For the past two years the DAO has been "promising" to produce special "swath" products for the AM1 instrument teams. The original idea for this came from Bob Evans of the MODIS Oceans team. He said they had had great difficulty interpolating NCEP 6-hourly low level wind products. He said they needed much higher temporal resolution. Hearing this, the DAO responded that their incremental analysis update (IAU) scheme could produce assimilated data at temporal resolutions up to a few minutes. In fact, at that time, the DAO already had a prototype "fly-through" system that could mimic an aircraft's flight path and pull out the assimilated data closest to the aircraft's location. It would be an easy conversion from this aircraft "fly-through" to a satellite "swath." In fact, the DAO has since developed a prototype swath module.

As the DAO advertised this capability, the other AM1 instrument teams also expressed interest. However, upon further investigation into the actual AM1 orbit, instrument swaths, and the scientific limitations of the GEOS DAS, it is now apparent that there is very little to be gained by geographically subsetting the data to match the satellite swath. Higher temporal resolution still makes sense, but not necessarily on a geographically subsetted grid. Here is how the DAO arrived at this conclusion:

**Original Subletting Design.** The AM1 platform has many different sensors, looking forward and aft and sweeping across the satellite track. Rather than try to match the assimilated output to the individual pixel location of all the different sensors the DAO decided to merely put out the data at their normal lat-long grid. They would leave the pixel interpolation up to the instrument teams. Furthermore, they decided to just draw a rectangle around the limits of the furthest looking instruments and subset the global data to this rectangle. The only problem is when the track goes over the poles. Here the rectangles become split and make for rather cumbersome subsetting. Rather than make thing too complicated, the DAO decided to produce the full latitude bands for any swath that went over the pole. This is the subsetting design in the prototype swath module.

**Temporal Resolution Limitations.** Although the model time step is on the order of a few minutes, most fields within the system are varying at much slower time scales. Furthermore, it costs 2 1/2 times as much computing time to put data out at every time step verses the current 3 and 6 hourly rates. Because of this high cost, the DAO hypothesized that the lowest reasonable temporal resolution would be about 10 minutes, and this would be only for the few products that vary significantly at this time scale. Tests with the DAO swath module at 10-minute resolution were encouraging, taking only 10% more computing time than the standard 3 and 6 hourly output.

**The AM1 Orbit and Swaths.** Using 10 minutes as the highest likely temporal resolution, the DAO then estimated the AM1 orbit and swaths to produce a prototype data set. First they considered the orbit period, 98 minutes, based on the satellite elevation, 705 km, which produces a ground track of approximately 400 km/min. Next they looked for the farthest looking instruments on AM1. CERES appeared to be the farthest, looking all the way out to the limb. Using very rough approximations, they determined the limb to

## Appendix B

### Mandatory Pressure and Model Sigma Levels

The World Meteorological Organization (WMO) has established the following mandatory pressure levels:

1000 mb	300 mb	50 mb	3.0 mb
925 mb	250 mb	30 mb	2.0 mb
850 mb	200 mb	20 mb	1.0 mb
700 mb	150 mb	10 mb	.7 mb
500 mb	100 mb	7 mb	.5 mb
400 mb	70 mb	5 mb	.4 mb

The objective analysis within the GEOS DAS is done at these mandatory pressure levels while the general circulation model (GCM) operates on model sigma levels. The GCM sigma levels are based on the following formula:

$$\sigma = (p - p_t) / (p_s - p_t)$$

where:  $p$  = pressure of the sigma level,

$p_t$  = pressure at the top of the GCM,

$p_s$  = surface pressure.

The GEOS DAS GCM uses 70 sigma levels from the surface to .01 mb. To aid in converting sigma levels to pressure levels, sigma files will include  $(p_s - p_t)$  and  $p_t$ .